Finite Element Model Planning for Structural Analysis

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The need for structural analysis can be triggered by several events. These can be broadly classified as design of a new structure or product; investigating use of an existing design for other uses; or investigation of failure of an existing design. How well a finite element model represents the real structure is dependent on the time, skill, and motivation applied by the analyst or analysis team. A good analysis based on a finite element model must be planned from the beginning, well before any computer model is generated. Often there are unrealistic or divergent expectations for a finite element analysis. Planning is essential to mitigate "surprises".

Administrative Planning Decisions

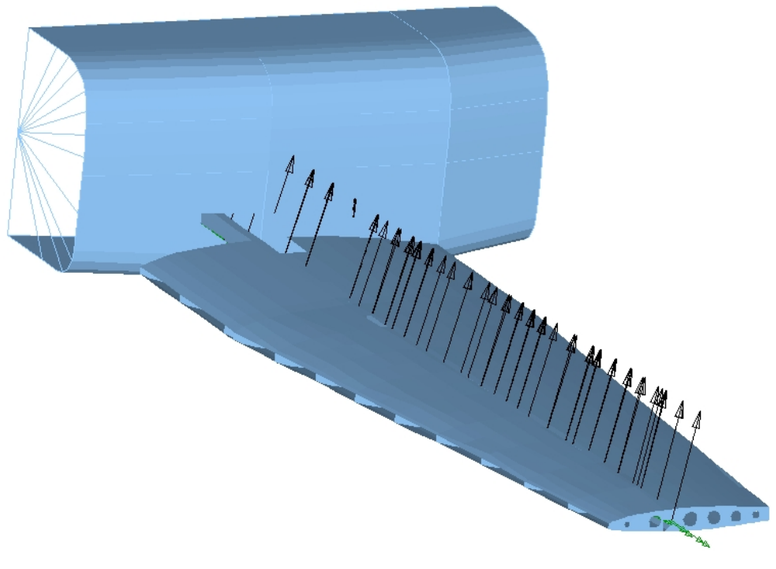
- What triggered the need for the analysis? What should be the skill set of the team performing the analysis?
- How much time is allotted for the finite element model? What is the schedule? If one asks for an answer in three weeks, one will get a "three week" answer. Maybe the "correct" answer will require some other timing.
- Is the structure for a safety critical application? What are the consequences of failure of the structure?
- Are there any requirements from the user of the structure, government regulations, industry standards or general liability concerns? What are the documentation, verification, reporting or validation requirements?
- Is there a procedure to record changes to the model or the modeling plan?

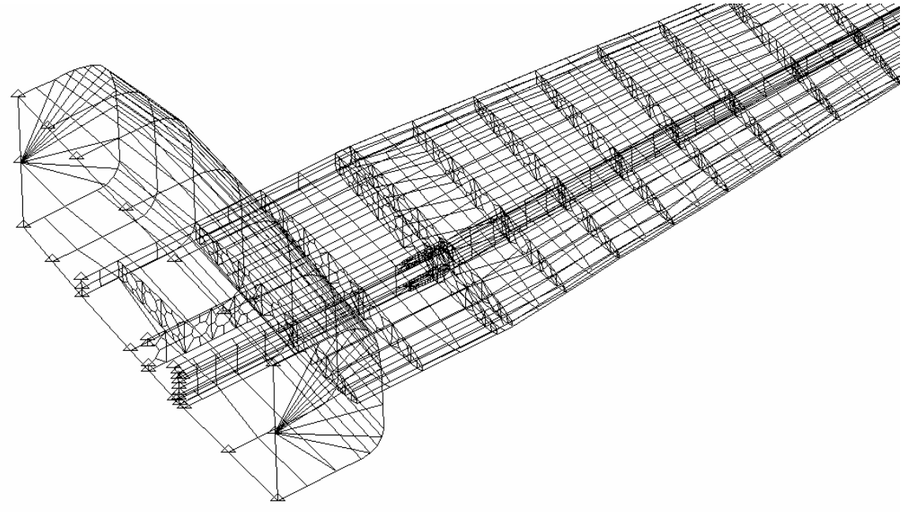
Design Group Coordination Decisions

- What are the sources of geometry? Will there be drawings or CAD? If CAD, are there compatibility issues with your pre-processor/modeling software? How will incompatibilities be resolved?
- What is the orientation of basic coordinate system? Is the positive z-axis up? Is the positive x-axis to the right? What does “up” or “right” mean, i. e. from what viewpoint?
- What is the source for material properties? Is a summary available to all analysts? Do the material properties have consistent units? What about temperature effects?

Interfacing Decisions

- How much of the structure will be included in the finite element model? What are the necessary boundaries for the model?
- Is the model grounded? Is the stiffness for attachment to the remainder of the structure defined? How will the stiffness for attachment to the remainder of the structure be defined?
- Is there an account of all external loads and boundaries on the real structure? A free body diagram is mandatory for all but simple structures. Decide how these external loads apply to the finite element model. Where did the external loads come from? What is the certainty in the external loads?





Procedural Planning Decisions

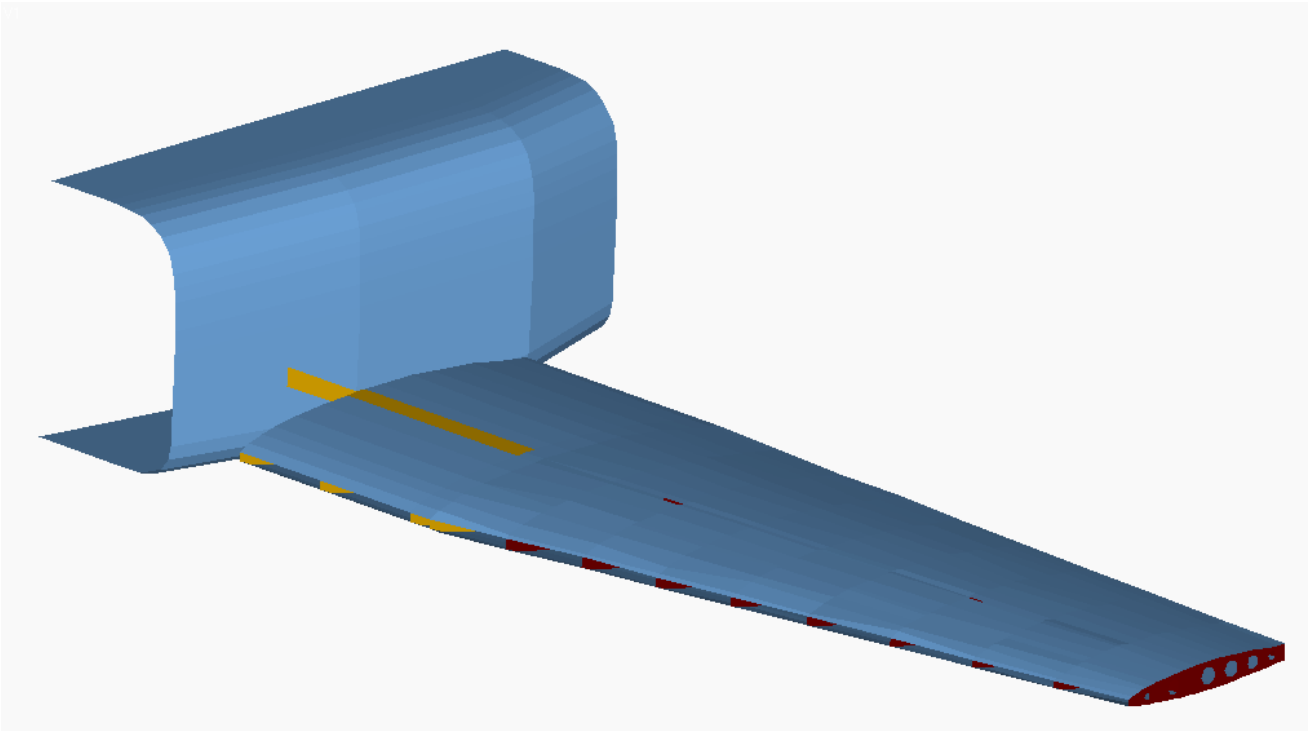
- What are the rules about generating the finite element mesh? Decide how automatic mesh generators are used. What is the average size of any element? How are beam centers offset from a surface? Decide on the use of solid elements for plates. Decide on a procedure for joining solid and plate elements.
- Are nominal or minimum material conditions used? If the structure is primarily plates, is the midplane or some other surface used? How are offsets due to material thickness handled?
- Do the mass properties have consistent units? Are the mass property units consistent with the other material property units? Who is responsible for insuring the mass calculated by the finite element model is in agreement with the calculation by the weights or design responsibility?
- Is a bolted or riveted joint modeling procedure defined? Are these springs, rigid bars, or beams? What about joining parts with different material thickness? How is stiffness or damping for joints defined?
- Is there a review procedure to account for all internal load paths in the structure?

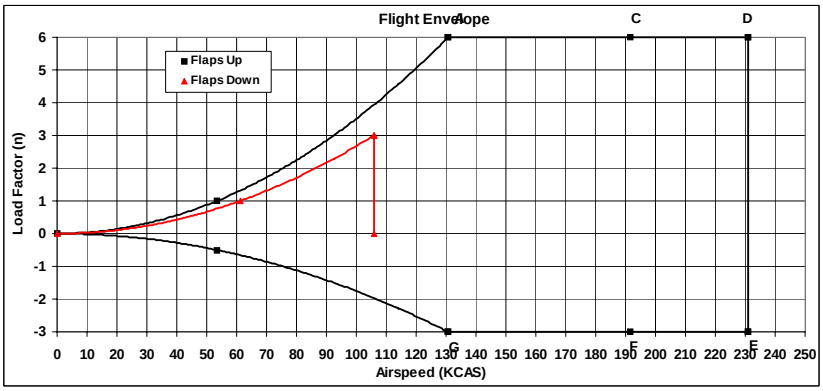
Planning for Using Results

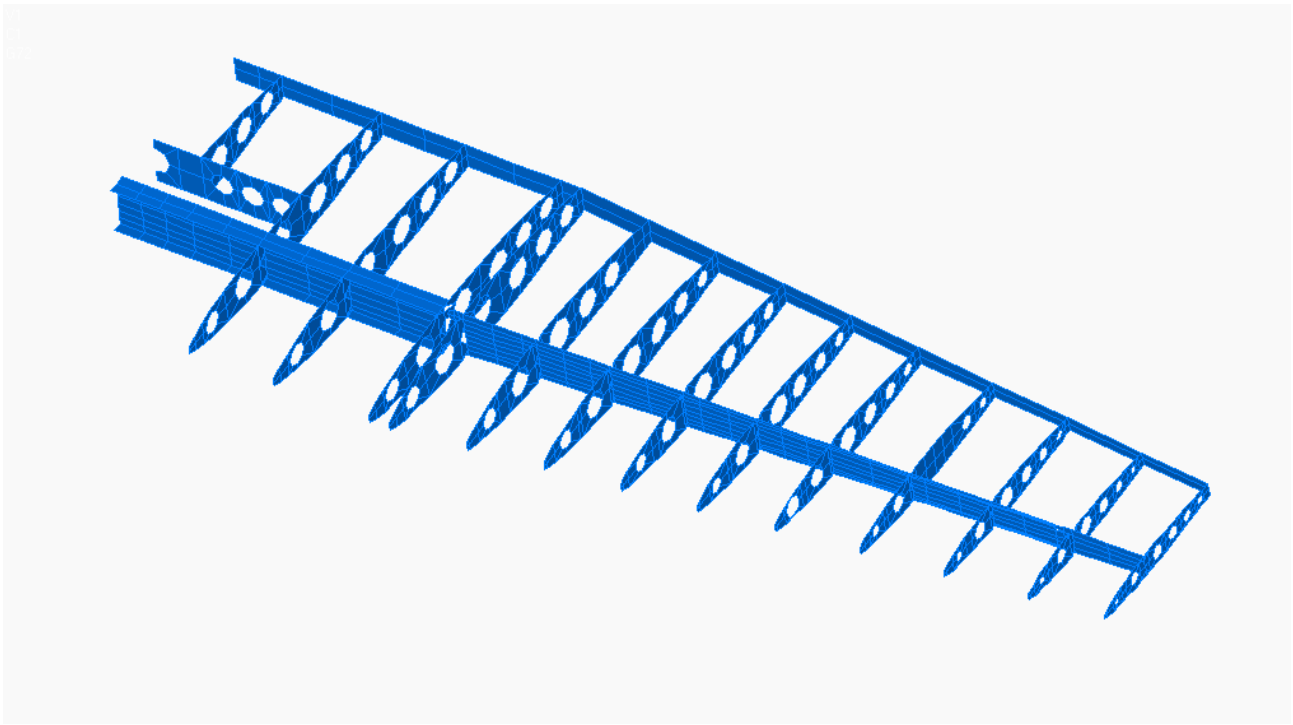
- What is the failure criterion? Is failure a maximum deflection, buckling, a maximum stress, fatigue, a resonance range, etc.? Define failure in the context of the particular structure and it's environment. If stress is used as a failure criteria, what kind of stress? Is it vonMises, maximum principal, etc.?
- What is the plan for verification of the model? Ideally, use deflections, stresses, or normal modes from tests. Is the analyst closely involved with the testing to insure that the analysis and test conform? Are there previous analyses and experience for reference?
- What is the procedure for checking the finite element model for good modeling practice? Is there a knowledgeable associate that can look at the model? What preprocessor, postprocessor and solver checks are available for this type of model and analysis?
- How will the results be presented? (Tabular data, contour plots, electronically, directly used in hand calculations, etc.)

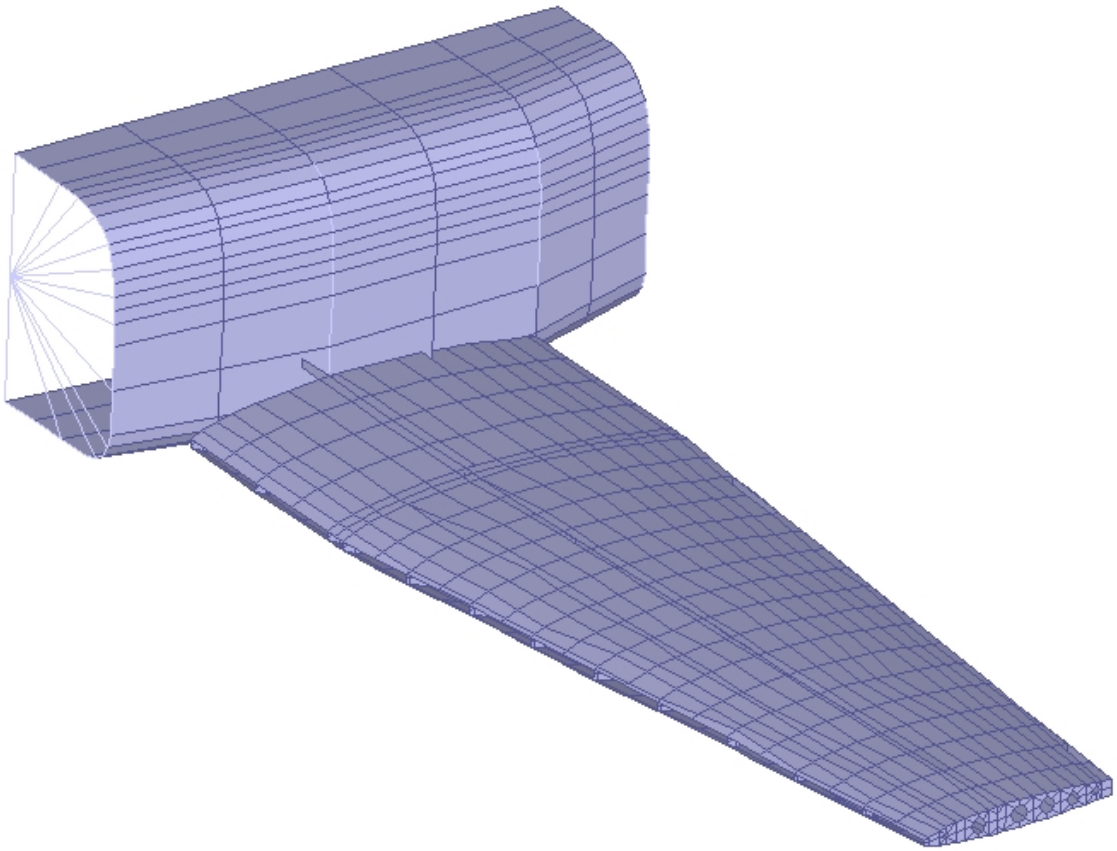
Usage Planning Decisions

- What is the intent of the model? Is this model a trade study, a general model, a detail design model, or a dynamic response model?
- Will one finite element model have several uses? (Static, dynamic, thermal, etc.)









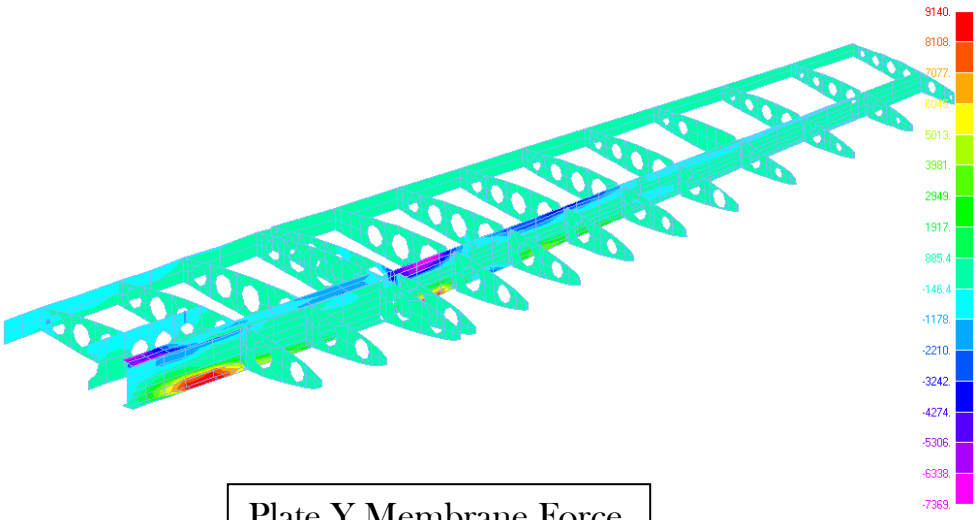
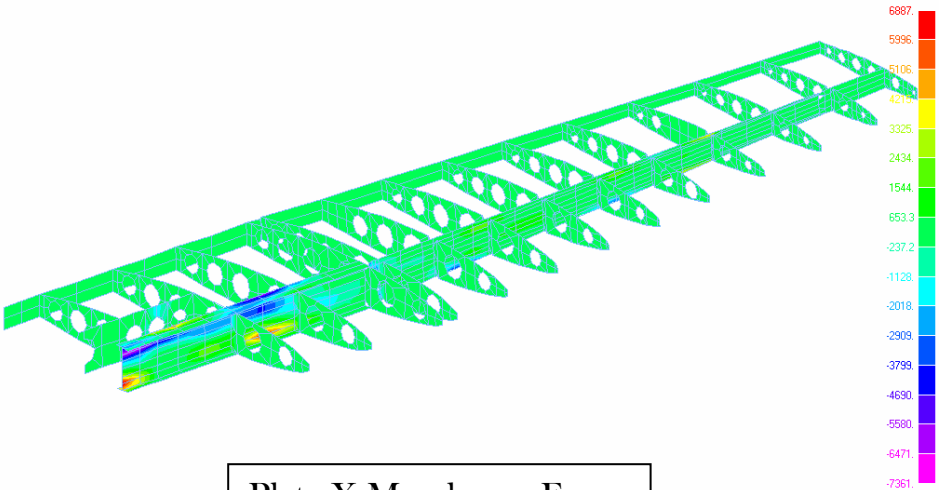


Plate Y Membrane Force



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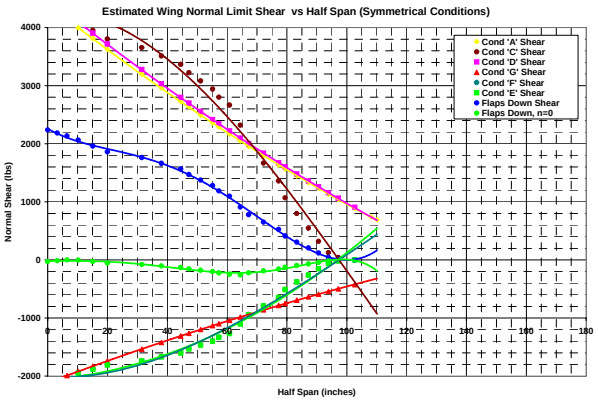
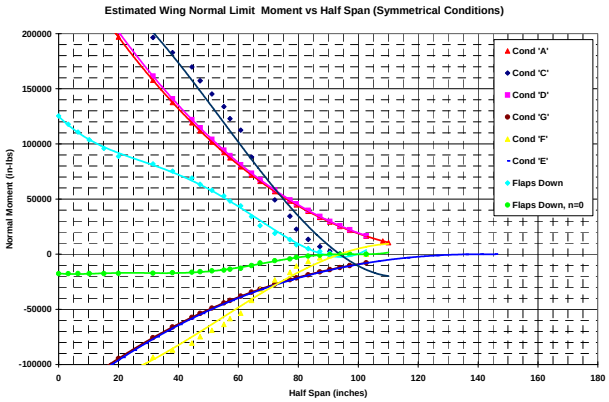


Shear vs Half Span



Moment vs Half Span